EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 70, 3549:3559, OCTOBER, 2024
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
FIXED PROSTHODONTICS AND DENTAL MATERIALS
Submit Date : 16-07-2024 • Accept Date : 14-08-2024 • Available online: 05-10-2024 • DOI : 10.21608/edj.2024.304575.3118

RADIOGRAPHIC EVALUATION OF CRESTAL BONE LOSS AROUND IMPLANTS IN MANDIBULAR ALL ON 4 IMPLANT HYBRID PROSTHESIS USING 2 DIFFERENT ABUTMENTS (MULTI-UNIT VERSUS OT BRIDGE)

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ABSTRACT

Aim of the study: The aim of this study was to evaluate bone loss around four immediately loaded implants using two different abutments OT bridge and mutli-unit abutments to support mandibular fixed-detachable prosthesis.

Materials and Methods: Four inter-foraminal mandibular implants, two axial anteriorly and two 30 degree tilted posteriorly, placed in 16 completely edentulous patients to immediately support fixed-detachable prosthesis opposing maxillary complete denture. Group I received OT bridge while group II received multi-unit abutments. Bone loss was evaluated immediately after loading, at 3, 6, and 12 months using CBCT for measurements.

Results: both groups demonstrated peri-implant crestal bone loss within the acceptable range but group I (OT Bridge) showed less bone resorption with significant statistical difference, no significant difference was observed between axial and 30-degree tilted implants. Bone loss was noticed higher from baseline and 3 months, then decreased in all other intervals.

Conclusion: Within the limitations of this study, fixed- detachable mandibular all on 4 prosthesis using OT Bridge abutments is highly recommended. OT Bridge showed great success, less peri-implant crestal bone resorption, Seeger rings gave extra means of retention.

KEY WORDS: All on 4, fixed-detachable prosthesis, mandibular prosthesis, OT bridge, Multi-unit abutments, Immediate loading, peri-implant bone loss.

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INTRODUCTION

Complete loss of teeth has negative impact on patient's life. Restoration of mandibular arch with complete denture did not improve the quality of life for many patients especially who experienced advanced mandibular resorption because of continuous movement of the lower denture which was found to cause further resorption associated with tissue inflammation. Implant overdenture had proved to offer great advantage for many patients with significant improvement of quality of life and patient satisfaction [1,2]. Nowadays, with increased demands of esthetics and interaction in social life, many patients asked for restoration with fixed prosthesis. Fixed prosthesis construction needs six mandibular implants at least with the challenge of absence of bone quantity and quality especially in patients with advanced bone resorption [3].

In the beginning of this century, Maló introduced the concept of all on 4 which created dental evolution, since then many companies are competing to introduce new attachment serving this treatment option. The advantage of all on 4 treatment is the reduction of number of implants inserted to support fixed prosthesis to 4 implants only which is more cost-effective. In addition, implant insertion inter-foraminal to avoid injury to the nerve, bone augmentation, nerve repositioning and further surgical procedures with added cost and complications, as there is insufficient bone height posteriorly in almost all cases with resorbed ridges. In this concept, two implants are placed anteriorly perpendicular to the occlusal plane and parallel to each other, and the other two posterior implants are placed with 30-45 degrees allowing the use of longer implants without endangering the integrity of the mental nerve, increasing the inter-implant distance thus improving support, and decrease the cantilever length with its detrimental effect [4].

Introduction of intra-oral scanners and digital impressions in dentistry facilitates fabrication of passive prosthesis, improves the accuracy, decreases time, material, complications resulting from delay of impression pouring, dimensional changes of materials or voids entrapped during impression taking or pouring; thus, it is considered more cost-effective. Furthermore, digital workflow starting from implant placement with the aid of computer-guided surgical stent ending with CAD/CAM milling of the hybrid prosthesis ensures highly accurate, passive prosthesis with minimum complications and minimum waste of time [5,6].

One of the most used abutments were the multi-unit abutments, these changed implant connection from internal hex to external one and transfer the prosthetic level to a higher occlusal level which is more protective to implants, also the use of angulated multi-unit abutments posteriorly in the angulated implants would favor force transmission along the long axis of implants and ensure more passive fit of the prosthesis [7,8].

The novel OT bridge system introduced by Rhein **(Rhein83, Bologna, Italy)** composed of low-profile OT equator suitable with any implant system, Seeger ring, and extra-grade titanium abutment which has a flat side should be positioned toward the maximum existing undercut, and the opening in the Seeger ring has to be aligned with the flat surface of the abutment, this system is claimed to fix severe angulations up to 80 degrees. Moreover, the Seeger ring provides inter-locking retention even before tightening the screws which allow the dentist to omit unesthetic screw opening without jeopardizing retention [8,9].

The aim of this study was to evaluate bone loss around four implants supporting screw-retained fixed mandibular prosthesis immediately loaded using OT bridge versus multi-unit abutments.

MATERIALS AND METHODS

Sixteen completely edentulous patients were participating in the study, the patients were chosen from the outpatient clinic in Faculty of Dentistry, Fayoum University. They had received complete denture recently but were complaining of inability to use the lower denture properly due to its continuous movements during function. After examination of the dentures, they were acceptable in every aspect, however, most of the patients had advanced mandibular bone resorption resulting in instability of the denture during function. Patients were given several treatment options with explanation of each and those who were selected in the study chose immediate loading mandibular fixed prosthesis supported on four inter-foraminal implants (all on 4 concept) opposing their maxillary complete denture. Discussion of treatment steps, benefits, and complications which may occur was done in a simplified manner, and signed informed consent was obtained from each patient after approval of the Ethical Committee, Faculty of Dentistry, Fayoum University.

Patients included in the study were medically free from any diseases that may interfere with surgical implant placement or osseointegration as diabetes mellitus, hemophilia; patients taking anticoagulants or those who had been under chemotherapy or radiotherapy were excluded from the study.

Panoramic x-ray was made for each patient to examine the presence of any pathological lesion, impacted tooth or remaining roots, then gutta percha were attached labially and buccally on the existing mandibular denture in the location of lateral incisors, canines, premolars then cone beam computed tomography (CBCT) was taken for the denture alone and the mandibular arch while the patient wearing and occluding on the denture (dual scan) for making fully guided tissue supported surgical stent for implant placement based on all on 4 concept; the two anterior implants were planned to be perpendicular on the occlusal plane and parallel to each other and the two posterior implants with 30 degree angulation. (Figure1)

Before surgery, each patient was instructed to take broad spectrum antibiotic amoxicillin clavulanate 2gm one hour before surgery [10] and rinse with chlorhexidine digluconate the day before surgery and on the same day of surgery to decrease the count of oral flora [11].

Under local anesthesia, the surgical stent was fixed to the mandible with fixation pins, tissue punch was used to remove tissue in the planned osteotomy sites (flapless technique), then osteotomy sites were drilled fully guided by the metal sleeves in the stent to preserve implant position and angulation. Surgical stent was removed, and each patient received four implants 3.7mm diameter and 11mm length **(Vitronex Elite, Italy)** (Figure 2) Implants were placed at crestal bone level with torque 35Ncm to guarantee proper initial stability and safe immediate loading.

Patients were randomly allocated into two equal groups. One group, OT equator for OT bridge system (**Rhein83®, Bologna, Italy**) (Figure 3) were used with 25Ncm tightening torque and the other group, multi-unit abutments **(Vitronex Elite, Italy)** two straight for the anterior implants and two angulated 30 degree for the posterior implants were screwed to the implants.

Complete denture was relieved from the fitting surface and after ensuring absence of any rocking around the attachments, vent holes were opened and any undercuts around the attachments and the access holes of screws were blocked by rubber band and Teflon, then the denture was inserted with soft liner and the patient instructed to occlude against the maxillary denture in centric relation. After setting of the material, the denture was finished and delivered to the patient as a temporary prosthesis for one week to allow healing of tissues for proper intra-oral scanning.

After one week, intra-oral scanning **(Medit i600, Seoul, South Korea)** was conducted to save the maxillary complete denture and maxilla-mandibular relationship and transfer the relation virtually, afterwards, the mandibular denture was removed and intra-oral scan was continued to locate implant position and capture the initial digital impression, then scan bodies for the multi-unit abutments **(Vitronex Elite, Italy)** were placed (hand tightened) and scannable extragrade abutments over the OT equator for the OT bridge group for determination of implant position and angulation, then splinting of scanning abutments were made using plastic rods and flowable composite for completion of intra-oral scanning (Figure 4). Scanning was obtained according to manufacturer's instructions, occlusal direction first, buccal, then lingual till elimination of any voids and accurate impression was acquired.

Resin pattern was fabricated for try-in to evaluate passive fit, then metal frameworks were 3D printed using base metal alloy for both groups. Try-in of metal framework was done, using single screw test to check passivity. After ensuring prosthesis adaptation and passive fit, porcelain was built up. Final prosthesis was tried in, occlusion was checked and adjusted then the prosthesis was screwed to the abutments. Access holes for screws were blocked by Teflon and covered by composite filling. For group I who received OT bridge system, after final prosthesis try-in, Seeger rings were tucked in their location inside the extra-grade abutments with their openings toward the flat side of abutments where the maximum undercuts were located (Figure 5).

Fig. (1) fully guided mucosa supported surgical stent

Fig. (2) implants insertion after removal of the stent, 2 axial and 2 with 30-degree angulation

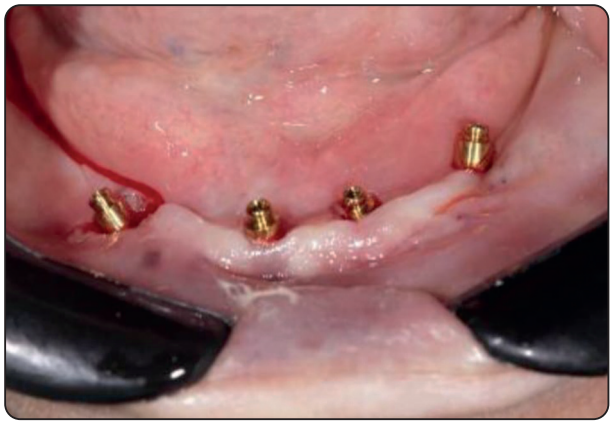

Fig. (3) OT equator in place

Fig. (4) splinted scannable extra-grade abutments on the OT equators

Fig. (5) intraoral final fixed detachable mandibular prosthesis

Follow-up was carried out immediately after loading, at intervals 3, 6, and 12 months. Assessment of peri-implant bone loss was measured using CBCT for its accurate, consistent, and reliable measurements. Bone level was measured from the junction between the abutment and implant, and the crest of the bone. Measurements were taken from the 4 sites mesial, distal, buccal, and lingual then the mean was determined for the axial and the tilted distal implants.

RESULTS

Statistical analysis was performed with SPSS 16® (Statistical Package for Scientific Studies), Graph pad prism & windows excel and presented in 3 tables and 3 graphs. Exploration of the given data was performed using Shapiro-Wilk test and Kolmogorov-Smirnov test for normality which revealed that data originated from normal data distribution. Accordingly, comparison between 2 different groups was performed by Independent t test, comparison between comparison between Axial implants and 30-degree tilted implants was performed by using Paired t test, moreover, comparison between different intervals was performed by using Repeated Measures ANOIVA followed by Tukey's Post Hoc test for multiple comparisons. The significance level was set at $p \leq 0.05$.

Comparison between group A and group B:

Comparison between Group A (OT Bridge) and Group B (Multi unit abutment), using Independent t test for the two sites: Axial implants and 30-degree tilted implants revealed that Group B demonstrated significantly higher bone changes than Group A with $P < 0.05$ regarding baseline -3 months, after 3 months- after 6 months, and baseline – after 12 months as presented in table (1) and figure (1).

Comparison between axial implants and 30-degree tilted implants:

Comparison between axial and 30-degree tilted implants in Group A (OT Bridge) and Group B (Multi unit abutment), using the Paired t test for revealed that there was insignificant difference between them regarding bone level changes in all intervals in both groups as $P>0.05$, as presented in table (2) and figure (2).

Comparison between bone level changes among different intervals in axial implants and 30-degree tilted implants in group A and B:

Comparison between bone level changes among different intervals in Group A (OT Bridge) and Group B (Multi unit abutment), using the Repeated Measures ANOVA test revealed that there was insignificant difference between bone level changes between different intervals regarding 30-degree tilted implants in Group B, while there was a significant difference ($P <0.05$), regarding Axial implants in Group A and B, also in 30-degree tilted implants in Group B as in baseline - after 3 months revealed significantly the highest amount of changes, while from after 3 months -after 6 months revealed significantly the least amount of bone changes, as presented in table (3) and figure (3).

TABLE (1) Comparison between group A and B using Independent t test:

		Group A (OT Bridge)		Group B (Multi-unit abutment)		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		P value
		Mean	Standard Deviation	Mean	Standard Deviation			Lower	Upper	
Axial implants	Baseline - After 3 months	0.32	0.06	0.5	0.07	0.18	0.03	0.11	0.24	0.0001*
	after 3 - 6 months	0.28	0.04	0.39	0.12	0.11	0.04	0.01	0.21	0.02*
	after 6 -12 months	0.2	0.07	0.28	0.18	0.08	0.06	-0.06	0.22	0.26
	Baseline - 12 months	0.8	0.17	1.17	0.27	0.37	0.11	0.12	0.61	0.005*
30-degree tilted implants	Baseline - After 3 months	0.36	0.06	0.51	0.07	0.15	0.03	0.09	0.22	0.0004*
	after 3 - 6 months	0.3	0.04	0.47	0.12	0.17	0.04	0.07	0.26	0.01*
	after 6 -12 months	0.24	0.07	0.36	0.18	0.12	0.06	-0.026	0.26	0.17
	Baseline - 12 months	0.9	0.19	1.28	0.37	0.18	0.03	0.11	0.24	0.0001*

Significant difference as P<0.05.

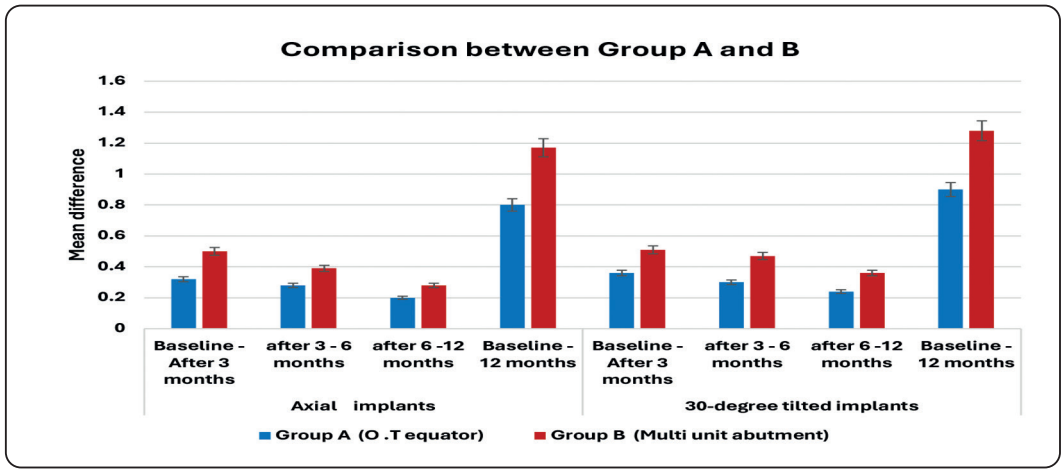

Fig. (1): Bar chart representing comparison between bone level changes in group A and B.

TABLE (2) Comparison between axial implants and 30-degree tilted implants using Paired t test:

		Axial implants		30-degree tilted implants		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		P value
		Mean	Standard Deviation	Mean	Standard Deviation			Lower	Upper	
Group A (OT Bridge)	Baseline - After 3 months	0.32	0.06	0.36	0.06	0.04	0.03	-0.02	0.11	0.23
	After 3 - 6 months	0.28	0.04	0.3	0.04	0.02	0.02	-0.02	0.06	0.33
	After 6 -12 months	0.2	0.07	0.24	0.07	0.04	0.03	-0.03	0.11	0.27
	Baseline - 12 months	0.8	0.17	0.9	0.19	0.1	0.09	-0.09	0.29	0.28
Group B (Multi unit abutment)	Baseline - After 3 months	0.5	0.07	0.51	0.07	0.01	0.03	-0.06	0.08	0.77
	After 3 - 6 months	0.39	0.12	0.47	0.12	0.08	0.06	-0.04	0.21	0.23
	After 6 -12 months	0.28	0.18	0.36	0.18	0.08	0.09	-0.11	0.27	0.38
	Baseline - 12 months	1.17	0.27	1.28	0.37	0.11	0.16	-0.23	0.45	0.51

Significant difference as P< 0.05.

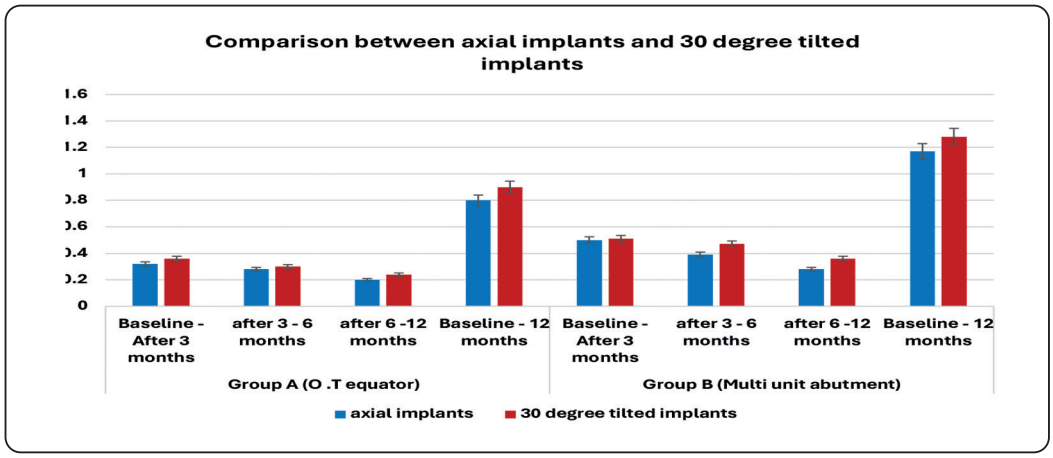

Fig. (2) Bar chart representing comparison between bone level changes in Axial implants and 30-degree tilted implants

TABLE (3) Comparison between Axial implants and 30-degree tilted implants using Repeated Measures ANOVA test:

		Baseline - After 3 months		after 3 - 6 months		after 6 -12 months		P value
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
Group A (OT Bridge)	Axial implants	0.32	0.06	0.28	0.04	0.2	0.07	0.0001*
	30-degree tilted implants	0.36 a	0.06	0.3 ab	0.04	0.24 b	0.07	0.001*
Group B (Multi unit abutment)	Axial implants	0.5 a	0.07	0.39 ab	0.12	0.28 b	0.18	0.01*
	30-degree tilted implants	0.51	0.07	0.47	0.12	0.36	0.18	0.08

significant difference as P<0.05.

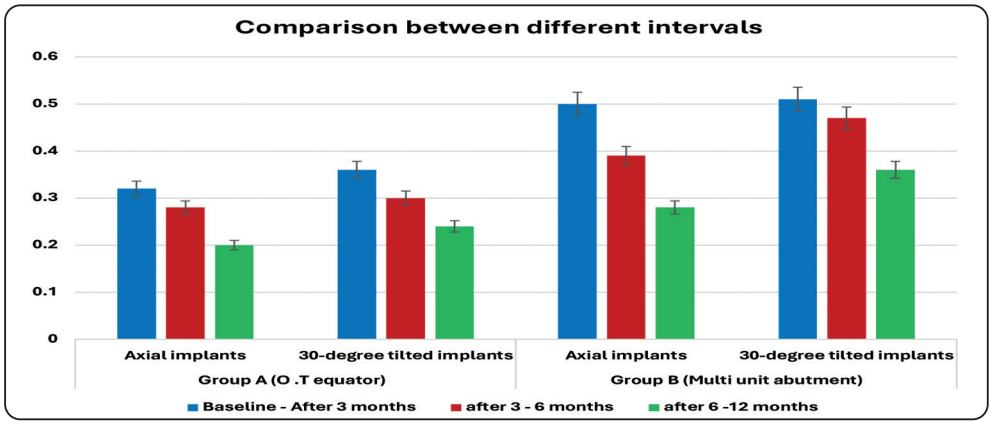

Fig. (3) Bar chart representing comparison between bone level changes among different intervals in Axial implants, and 30-degree tilted implants.

DISCUSSION

The use of dual scan to obtain fully guided surgical stent guarantees a more precise and previously planned implant placement without risk of invading nerve canal or causing pressure on the nerve and accurate implant angulation to decrease cantilever load, furthermore its use made it easier to use flapless technique with fewer postoperative complications. This approach saves time, and it is more acceptable for patients [12,13].

Surgery was done under prophylactic antibiotic coverage, although there is a debate about essential usage in every case, but many studies recommended its use either pre or postoperative to decrease implant failure [10,14].

All on 4 technique showed great success with the advantage of fixed prosthesis supported on fewer number of implants, at the same time this technique provides the dentist with easy retrievability as it is screw retained fixed detachable prosthesis.

Digital impression technique was used in this study as it is more accurate eliminating errors occur with regular impression technique either movements of impression copings during screwing implant analogues after picked up or impression

voids around implants, dimensional changes in the impression or the stone after pouring [5,8].

The novel OT Bridge system using Seeger ring adds more retentive force by snap-on the prosthesis other than the screws used to retain it, some studies omitted one or two anterior screws for esthetic reasons, depending on the retentive capacity of the Seeger ring, to evaluate stresses induced around the OT equator and complications that may encounter. Their recommendation was it is safe and stable to use all on 4 prostheses with the absence of one anterior screw. However, most studies were in vitro evaluating finite element analysis on models [15-17].

CBCT used to assess bone resorption because its accuracy and easy to measure precisely and compare results. Measurements were taken from the 4 sites mesial, distal, buccal, and lingual which could not be measured using 2 dimensional techniques [18-21].

Results showed that bone loss for both groups was within the normal range at the end of the first year, no implant was lost or showed signs of failing. However, there was a statistical difference in bone loss between the 2 groups in favor of the OT bridge system, this may be encountered for the use of the Seeger ring with its retentive function and resilient nature might absorb most of the force acting on the prosthesis thus aids in maintaining all screws in place, decreasing the chance for screw loosening and subsequent micro-movement of prosthesis which may induce bone resorption [22-24].

On the contrary, multi-unit abutments although have high success rate but the two-screw system is responsible for high rate of screw loosening and even screw fractures due to the thin weak screws, in addition to micro-organisms aggregation in the micro-spaces between implants and abutments which may lead to peri-implantitis with accompanied peri-implant bone loss [25-29].

Bone loss was noticed more around the distal tilted implants than around the axial implants in both groups, but with insignificant difference, these results were in accordance with several finite element analysis studies which found elevated stress concentration around tilted implants which is interpreted clinically by increase peri-implant marginal bone resorption [30-32].

The rate of bone resorption was faster in the first 3 months after loading in both groups, this might be attributed to the remodeling of bone after immediate loading of fixed prosthesis with final metal framework.

CONCLUSION

Within the limitations of this study, the new OT bridge system showed promising results encouraging its use, peri-implant bone loss was significantly lower than multi-unit abutments after one year.

Conflict of interest

The authors declared no conflict of interests related to this study.

Funding

This study was self-funded by the authors.

Contribution

All authors had read, revised, and approved the manuscript.

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